DETAILED ACTION

Response to Amendment

1. The Examiner acknowledges the amended claims filed on October 6, 2009. **Claim 60** has been amended. **Claims 1-25, 29, 36, 39 and 49-56** have been cancelled. **Claims 63 and 34** have been newly added.

Response to Arguments

2. Applicant's arguments filed October 6, 2009 have been fully considered but they are not persuasive.

3. The Applicant argues the following:

a. “The Office Action states that Denyar '438 teaches this limitation at page 12, lines 10-19 where Denyar '438 states that the "color channels are interpolated to provide missing data by low-pass-filtering using a square area template" and that "the component colour channel represents a lowpass-filtered (spatially smoothed) version of the ideal component colour channel response." (Office Action, page 8). <u>Applicants respectfully disagree with the Office Action's conclusion because Denyar '438 does not teach or suggest what data is used from the square area template to conduct the interpolation or obtain a spatially smoothed version of the ideal component colour channel response. Using a green pixel as an example, as suggested by the Office Action at page 8, Denyar '438 does not teach or suggest estimating the level of the red or blue light received</u>

by a green pixel based on a measurement of the red or blue light obtained by a red or blue pixel, and instead only describes "using a square area template". (Denyar '438). Therefore, Denyar '438 does not teach or suggest estimating "the level of the first spectral component in the light received by at least one of the second photosensitive sites based on at least one measurement of the first spectral component obtained respectively by at least one of the first photosensitive sites" as recited by claim 26".

The Office Action also states that Denyar '438 "discloses that for luminance determination, the Green color component is calculated performing interpolation of Green color components surrounding sites that do not receive Green color to obtain the luminance component for said sites" at page 13, line 8 -page 15, line 20 of Denyar '438. (Office Action, page 8). Applicants respectfully disagree with this statement. At page 13, line 8 - page 15, line 20, Denyar '438 only discusses estimating luminance, and does not disclose estimating the level of a spectral component of light. Therefore the portion of Denyar cited by the Office Action is irrelevant to the current rejection of claim 26.

➢ The Examiner disagrees. It is noted from page 12, lines 10-37, that Denyer discloses calculating the values of the green colour on a site that is not green (i.e. Red or Blue). This can also be shown in fig. 4, wherein a pixel is verified whether is a green pixel or not, if is not a green pixels, the values of the green pixels surrounding the target pixel are averaged (or

interpolated) to obtain the corresponding green value. Furthermore, Denyer discloses tin page 12, ¶ 26-32 that the green pixels are elected to be "luminance-sensing" pixels and Green pixel signals are taken to be representative of luminance as well as being "representative of Green colour. Thus, even if in Denyer, the luminance value is calculated, the values of the green pixels are used to estimate the luminance value or green value on a red or blue pixel (Note that the Examiner interpreted the first spectral component as Green and the Second spectral component as Blue, therefore, Denyer discloses estimating the level of the first spectral component (Green) in the light received by at least one of the second photosensitive sites (capturing either red or blue) based on at least one measurement of the first spectral component obtained respectively by at least one of the first photosensitive sites as claimed). It is also noted that in page 13, line 8 -page 15, line 20, specifically in page 15, lines 1-20, Denyer recites "*<u>The estimated luminance signal obtained for a non-Green pixel sited at the centre of both a row and a column of five pixels provides an estimated luminance signal for the fourth i.e. luminance channel of the camera</u>. This signal then has subtracted from it a spatially smoothed version of the luminance-representative signal, this being the particular output of a 5 x 5 square area lowpass-filtering template corresponding to the colour used for luminance sensing (in this case Green). This technique, sometimes known as "un-sharp masking", obtains a signal which approximates to a highpass-filtered (i.e. "edge-extracted")*

luminance signal. The "edge-extracted" signal is then superimposed on to the spatially-smoothed colour channel signals obtained over the same 5 x 5 pixel area so as to produce a Red, Green, Blue (RGB) pixel triplet including full colour and luminance information. RGB pixel triplet signals obtained in this way enable the camera to produce a contour-enhanced image which is more resolved, and thus more pleasing, to the human eye, than the image obtained purely from the spatially smoothed colour channel signals." This further teaches that the spectral components are also calculated since Denyer teaches that the luminance components are applied to spatially-smoothed colour channels obtained over the same 5 x 5 pixel area so as to produce a Red, Green, Blue (RGB) pixel triplet including full colour and luminance information. Also, Denyer discloses the use of a lowpass filter (28) to restore the colour values from the 5 x 5 pixel area as shown in fig. 7.

➢ The Examiner understands that the Denyer reference teaches all the limitations of claim 26 as presented. Therefore, the rejections are maintained.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

5. Claims 26-28, 30-35, 37, 38, 40, 42, 58 and 63 are rejected under 35 U.S.C. 102(a) as being anticipated by Denyer et al., WO 97/35438 A1.

6. **Regarding claim 26**, **Denyer et al.** discloses an imager (*See fig. 7*), comprising:

a semiconductor substrate (*Denyer et al. discloses a semiconductor substrate by disclosing that the imager is part of a single chip camera and that the production process of the image sensor is well disposed to deposition of the color filters when the products are in silicon-wafer form. See fig. 7, page 16, lines 13-21*);

an array of photosensitive sites (*Fig. 7: 23; see also fig. 1; page 11, lines 29-37; page 12, lines 1-8*) located on the substrate (*Note that the sensor array 23 is located on the single camera chip 20 as shown in fig. 7 (See page 18, lines 5-30; also page 12, lines 1-8). This teaches that the array of photosensitive sites is located on the substrate*), the array including

a plurality of first photosensitive sites (*See fig. 1*) having a plurality of first color filters (*As shown in fig. 1, Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors. For examination purposes, the*

Examiner is interpreting the Green color filters as the plurality of first color filters) arranged above said first photosensitive sites to allow only a first spectral component of light to reach said first photosensitive sites (*Denyer et al. discloses that the pixels are covered with color filters corresponding to desired spectral components. See page 12, lines 1-8. See also fig. 1, which shows the arrangement of Red, Green and Blue colors. This teaches that the first sensitive sites are covered with a plurality of first color filters (corresponding to green color as interpreted by the Examiner) to allow only a first spectral component (Green) of light to reach said first photosensitive sites*), wherein each first photosensitive site comprises a configuration enabling each first photosensitive site to measure the level of a first spectral component in light received (Green color components) by the respective first photosensitive site (*See page 12, lines 1-19*), and

a plurality of second photosensitive sites having a plurality of second color filters (*As shown in fig. 1, Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors. For examination purposes, the Examiner is interpreting the Blue color filters as the plurality of second color filters*) arranged above said second photosensitive sites to allow only a second spectral component of light to reach said second photosensitive sites (as discussed above, *Denyer et al. discloses that the pixels are covered with color filters corresponding to desired spectral components. See page 12, lines 1-8. See also fig. 1, which shows the arrangement of Red, Green and Blue colors. This teaches that the second sensitive sites are covered with a plurality of second color filters (corresponding to Red color as interpreted by the Examiner)*

to allow only a first spectral component (Green) of light to reach said first photosensitive sites), wherein each second photosensitive site comprises a configuration enabling each second photosensitive site to measure the level of a second spectral component in light received (*Red color components*) by the respective second site (*See page 12, lines 1-19*), said second spectral component being different from said first spectral component (*Note that the Examiner is interpreting the first color component as Green and the second color component as Red, which are different from each other*); and

an interpolator (*See processor subsystem 25 as shown in fig. 7. Denyer et al. discloses performing interpolation on the color components using low-pass filter 28 and also teaches performing interpolation for obtaining the luminance components of the captured image data. See page 18, lines 5-30; see also page 12, lines 10-37; page 13, line 8 – page 14, line 10; page 15, lines 1-20*) located on the substrate (*Denyer et al. discloses that the processor subsystem is located on the same chip as the array of photosensitive sites. See page 18, lines 5-30; also page 16, lines 13-21*) and comprising a configuration enabling the interpolator to estimate the level of the first spectral component (*Green color*) in the light received by at least one of the second photosensitive sites (*Photosensitive sites measuring a color other than Green (i.e. Red)*) based on at least one measurement of the first spectral component obtained respectively by at least one of the first photosensitive sites (*Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at*

least one measurement of the first spectral component (Green color) to estimate the level of the first spectral component (Green color) in the light received by at least one of the second photosensitive sites since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Green color) is obtained (See page 12, lines 10-19). Denyer et al. also discloses that for luminance determination, the Green color component is calculated by performing interpolation of Green color components surrounding sites that do not receive Green color to obtain the luminance component for said sites (See figs. 3 and 4; page 13, line 8 – page 15, line 20)).

7. **Regarding claim 27**, **Denyer et al.** discloses that the first spectral component is a primary color of light (*As shown in fig. 1, Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors. For examination purposes, the Examiner is interpreting the Green color filters as the first spectral component which is a primary color of light*).

8. **Regarding claim 28**, **Denyer et al.** discloses that each second photosensitive site comprises a configuration enabling each second photosensitive site to measure the level of a second spectral component in light (*Red color component*) received by the respective second photosensitive site (*Since Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors covering the array of photosensitive sites (See fig. 1). For*

examination purposes, the Examiner is interpreting the light received by the photosensitive sites with the Red color filters as the second spectral component in light measured by the respective second photosensitive site), and

the interpolator further comprises a configuration enabling the interpolator configured to estimate the level of the second spectral component (*Red color*) in the light received by at least one of the first photosensitive sites (*Photosensitive sites measuring Green color*) based on at least one measurement of the second spectral component (*Red color*) obtained respectively by at least one of the second photosensitive sites (*As discussed in claim 26, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one measurement of the second spectral component (Red color) to estimate the level of the second spectral component (Red color) in the light received by at least one of the first photosensitive sites (Photosensitive sites measuring Green color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Red color) is obtained (See page 12, lines 10-19)*).

9. **Regarding claim 30**, **Denyer et al.** discloses a plurality of third photosensitive sites (*Since Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors covering the array of photosensitive sites (See fig. 1). For examination purposes, the Examiner is interpreting the photosensitive sites covered by a Blue color filter as third photosensitive sites*), and

the interpolator further comprises a configuration enabling the interpolator to estimate the level of the first spectral component (*Green color*) in the light received by at least one of the third photosensitive sites (*photosensitive sites measuring Blue color*) based on at least one measurement of the first spectral component (*Green color*) obtained respectively by at least one of the first photosensitive sites (*As discussed in claim 26, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one measurement of the first spectral component (Green color) to estimate the level of the first spectral component (Green color) in the light received by at least one of the third photosensitive sites (Photosensitive sites measuring Blue color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Green color) is obtained on the photosensitive sites measuring a different color (in this case Blue color) (See page 12, lines 10-19)*), and to estimate the level of the second spectral component (*Red color*) in the light received by at least one of the third photosensitive sites (*photosensitive sites measuring Blue color*) based on at least one measurement of the second spectral component (*Red color*) obtained respectively by at least one of the second photosensitive sites (*photosensitive sites measuring Red color*) (*As discussed in claim 26, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one measurement of the second spectral component (Red*

color) to estimate the level of the second spectral component (Red color) in the light received by at least one of the third photosensitive sites (Photosensitive sites measuring Blue color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Red color) is obtained on the photosensitive sites measuring a different color (in this case Blue color) (See page 12, lines 10-19)).

10. **Regarding claim 31**, **Denyer et al.** discloses that each third photosensitive site has a plurality of third color filters (*As shown in fig. 1, Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors. For examination purposes, the Examiner is interpreting the Blue color filters as the plurality of third color filters*) arranged above said third photosensitive sites to allow only a third spectral component of light to reach said third photosensitive sites (*Denyer et al. discloses that the pixels are covered with color filters corresponding to desired spectral components. See page 12, lines 1-8. See also fig. 1, which shows the arrangement of Red, Green and Blue colors. This teaches that the third photosensitive sites are covered with a plurality of third color filters (corresponding to Blue color as interpreted by the Examiner) to allow only a third spectral component of light (Blue color) to reach said third photosensitive sites*), and wherein each third photosensitive site comprises a configuration enabling each third photosensitive site to measure the level of a third spectral component (Blue color component) in light received by the respective third photosensitive site (*Since Denyer et al. discloses a checkerboard*

pattern filter for Red, Green, and Blue colors covering the array of photosensitive sites (See fig. 1). For examination purposes, the Examiner is interpreting the light received by the photosensitive sites with the Blue color filters as the third spectral component in light measured by the respective second photosensitive site), and

the interpolator further comprises a configuration enabling the interpolator configured to estimate the level of the third spectral component (*Blue color*) in the light received by at least one of the first photosensitive sites (*Photosensitive sites measuring Green color component*) and/or at least one of the second photosensitive sites (*Photosensitive sites measuring Red color component*) based on at least one measurement of the third spectral component obtained respectively by at least one of the third photosensitive sites (*As discussed in claim 26, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one measurement of the third spectral component (Blue color) to estimate the level of the third spectral component (Blue color) in the light received by at least one of the first photosensitive sites (Photosensitive sites measuring Green color) and/or at least one of the second photosensitive sites (Photosensitive sites measuring Red color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Green color) is obtained on the photosensitive sites measuring a different color (in this case Green and Red color components) (See page 12, lines 10-19)*).

11. **Regarding claim 32**, **Denyer et al.** discloses that the first spectral component is a first primary color of light (*As discussed in claims 26 and 27, as interpreted by the Examiner the first spectral component is the Green color which is the first primary color of light*),

the second spectral component is a second primary color of light (*As discussed in claims 26 and 28, as interpreted by the Examiner the second spectral component is the Red color which is the second primary color of light*), and

the third spectral component is a third primary color of light (*As discussed in claim 30, as interpreted by the Examiner the third spectral component is the Blue color which is the third primary color of light*), Grounds for rejecting claims 26-28, 30 and 31 apply here.

12. **Regarding claim 33**, **Denyer et al.** discloses a line decoder (*Readout circuit 24 as shown in fig. 7*) located on the substrate (*Note in fig. 7 that the readout circuit 24 is located on the same chip as the array of photosensitive sites 23 and the interpolator 25 (processor subsystem)*) and having at least one serial output for transferring out at least one line of measured spectral components from the array during a read out operation (*Denyer et al. discloses that five lines of five pixels forming a block are read out from the array of photosensitive sites 23 and output to an A/D converter (A/D block as shown in fig. 7), that would further output the digitized signals to a five-line memory (Fig. 7: 26) (See page 18, lines 5-30). Therefore, Denyer et al. discloses that the line decoder 24 has at*

least one serial output for transferring out at least one line of measured spectral components from the array during a read out operation as claimed); and

an A/D conversion element (*A/D block as shown in fig. 7*) located on the substrate (*Note that the A/D block is also part of the single chip camera as shown in fig. 7, therefore is also located on the substrate*) and comprising a configuration enabling the A/D conversion element to receive the at least one line of measured spectral components read out from the line decoder (*Denyer et al. discloses that the five lines of said five pixels forming the block output from the readout circuit 24 are received by the A/D converter (A/D as shown in fig. 7). See page 18, lines 5-30*) and output the received measurements as digital values to the interpolator (*Denyer et al. discloses that the A/D converter digitizes the received signals from the readout circuit 24 and output said digitized signals to the interpolation circuits (low pass filter 28 and block 30 (which perform interpolation for determining the luminance values)). See page 18, lines 10-19*), and

wherein the interpolator estimates the first spectral component levels in the second and third photosensitive sites (*As discussed in claims 26 and 30, Denyer et al. discloses estimating the first spectral component levels (Green color) in the second (Photosensitive sites measuring Red color) and third (Photosensitive sites measuring Blue color) photosensitive sites*),

the second spectral component levels in the first and third photosensitive sites (*As discussed in claims 28 and 30, Denyer et al. discloses estimating the second spectral component levels (Red color) in the first (Photosensitive sites*

measuring Green color) and third (Photosensitive sites measuring Blue color) photosensitive sites), and

the third spectral component level in the first and second photosensitive sites based on the digital values received from the A/D conversion element (*As discussed in claim 31, Denyer et al. discloses estimating the third spectral component levels (Blue color) in the first (Photosensitive sites measuring Green color) and second (Photosensitive sites measuring Red color) photosensitive sites*) based on the digital values received from the A/D conversion element (*As shown in fig. 7, the interpolation performed by the low pass filter 28 and block 30 (which perform interpolation for determining the luminance values), perform the color estimation based on the digital values output by the A/D converter (A/D block), which output the digital values to the 5-line memory 27 and the values stored in the 5-line memory are read out to the interpolation elements. See page 18, lines 5-30*).

13. **Regarding claim 34**, **Denyer et al.** discloses a line decoder (*Readout circuit 24 as shown in fig. 7*) located on the substrate (*Note in fig. 7 that the readout circuit 24 is located on the same chip as the array of photosensitive sites 23 and the interpolator 25 (processor subsystem)*) and having at least one serial output for transferring out at least one line of measured spectral components from the array during a read out operation (*Denyer et al. discloses that five lines of five pixels forming a block are read out from the array of photosensitive sites 23 and output to an A/D converter (A/D block as shown in fig. 7), that would*

further output the digitized signals to a five-line memory (Fig. 7: 26) (See page 18, lines 5-30). Therefore, Denyer et al. discloses that the line decoder 24 has at least one serial output for transferring out at least one line of measured spectral components from the array during a read out operation as claimed); and

an A/D conversion element (*A/D block as shown in fig. 7*) located on the substrate (*Note that the A/D block is also part of the single chip camera as shown in fig. 7, therefore is also located on the substrate*) and comprising a configuration enabling the A/D conversion element to receive the at least one line of measured spectral components read out from the line decoder (*Denyer et al. discloses that the five lines of said five pixels forming the block output from the readout circuit 24 are received by the A/D converter (A/D as shown in fig. 7). See page 18, lines 5-30*) and output the received measurements as digital values to the interpolator (*Denyer et al. discloses that the A/D converter digitizes the received signals from the readout circuit 24 and output said digitized signals to the interpolation circuits (low pass filter 28 and block 30 (which perform interpolation for determining the luminance values)). See page 18, lines 10-19*), and

wherein the interpolator estimates the first spectral component levels in the second photosensitive sites based on the digital values received from the A/D conversion element (*As discussed in claims 26 and 30, Denyer et al. discloses estimating the first spectral component levels (Green color) in the second photosensitive sites (Photosensitive sites measuring Red color). See page 12, lines 10-19*).

14. **Regarding claim 35**, **Denyer et al.** discloses a line decoder (*Readout circuit 24 as shown in fig. 7*) located on the substrate (*Note in fig. 7 that the readout circuit 24 is located on the same chip as the array of photosensitive sites 23 and the interpolator 25 (processor subsystem)*) and having at least one serial output for transferring out at least one line of measured spectral components from the array during a read out operation (*Denyer et al. discloses that five lines of five pixels forming a block are read out from the array of photosensitive sites 23 and output to an A/D converter (A/D block as shown in fig. 7), that would further output the digitized signals to a five-line memory (Fig. 7: 26) (See page 18, lines 5-30). Therefore, Denyer et al. discloses that the line decoder 24 has at least one serial output for transferring out at least one line of measured spectral components from the array during a read out operation as claimed*), wherein the at least one serial output of the line decoder transfers out either several sequential lines or a block of measured spectral components from the array during each read out operation (*As discussed above, Denyer et al. discloses that five lines of five pixels forming a block are read out from the array of photosensitive sites 23 and output to the A/D converter. Therefore, Denyer et al. discloses that at least one serial output of the line decoder transfers out either several sequential lines (since the line decoder transmits data (five pixels per line) from five sequential lines) or a block of measured spectral components from the array during each read out operation (since the five lines output belong to a block in the array of photosensitive sites, the block being used to estimate the missing color values). See page 18, lines 5-30*).

15. **Regarding claim 37**, **Denyer et al.** discloses an imager (*See figs. 1 and 7*), comprising:

a semiconductor substrate (*Denyer et al. discloses a semiconductor substrate by disclosing that the imager is part of a single chip camera and that the production process of the image sensor is well disposed to deposition of the color filters when the products are in silicon-wafer form. See fig. 7, page 16, lines 13-21*);

a plurality of first photosensitive sites (*Fig. 7: 23; see also fig. 1; page 11, lines 29-37; page 12, lines 1-8*) located on the substrate (*Note that the sensor array 23 is located on the single camera chip 20 as shown in fig. 7 (See page 18, lines 5-30; also page 12, lines 1-8). This teaches that the plurality of first photosensitive sites is located on the substrate*), said plurality of first photosensitive sites (*See fig. 1*) having a plurality of first color filters (*As shown in fig. 1, Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors. For examination purposes, the Examiner is interpreting the Green color filters as the plurality of first color filters*) arranged above said first photosensitive sites to allow only a first spectral component of light to reach said first photosensitive sites (*Denyer et al. discloses that the pixels are covered with color filters corresponding to desired spectral components. See page 12, lines 1-8. See also fig. 1, which shows the arrangement of Red, Green and Blue colors. This teaches that the first sensitive sites are covered with a plurality of first color filters (corresponding to green color as interpreted by the Examiner) to allow only a first spectral component (Green) of light to reach said first photosensitive sites*),

wherein each first photosensitive site comprises a configuration enabling each first photosensitive site to measure the level of a first spectral component (Green color components) in light received by the respective first photosensitive site (*See page 12, lines 1-19*);

a plurality of second photosensitive sites (*Fig. 7: 23; see also fig. 1; page 11, lines 29-37; page 12, lines 1-8*) located on the substrate (*Note that the sensor array 23 is located on the single camera chip 20 as shown in fig. 7 (See page 18, lines 5-30; also page 12, lines 1-8). This teaches that the plurality of second photosensitive sites is located on the substrate*), said plurality of second photosensitive sites having a plurality of second color filters (*As shown in fig. 1, Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors. For examination purposes, the Examiner is interpreting the Blue color filters as the plurality of second color filters*) arranged above said second photosensitive sites to allow only a second spectral component of light to reach said second photosensitive sites (as discussed above, *Denyer et al. discloses that the pixels are covered with color filters corresponding to desired spectral components. See page 12, lines 1-8. See also fig. 1, which shows the arrangement of Red, Green and Blue colors. This teaches that the second sensitive sites are covered with a plurality of second color filters (corresponding to Red color as interpreted by the Examiner) to allow only a first spectral component (Green) of light to reach said first photosensitive sites*), wherein each second photosensitive site comprises a configuration enabling each second photosensitive site to measure the level of a second spectral component (*Red*

color component) in light received by the respective second photosensitive site, said second spectral component being different from said first spectral component (*Note that the Examiner is interpreting the first color component as Green and the second color component as Red, which are different from each other*); and

an interpolator (*See processor subsystem 25 as shown in fig. 7. Denyer et al. discloses performing interpolation on the color components using low-pass filter 28 and also teaches performing interpolation for obtaining the luminance components of the captured image data. See page 18, lines 5-30; see also page 12, lines 10-37; page 13, line 8 – page 14, line 10; page 15, lines 1-20*) located on the substrate (*Denyer et al. discloses that the processor subsystem is located on the same chip as the array of photosensitive sites. See page 18, lines 5-30; also page 16, lines 13-21*) and comprising a configuration enabling the interpolator to receive digital data (digitized by A/D converter (*A/D block as shown in fig. 7*)) representing the spectral component levels measured in the first photosensitive sites (*photosensitive sites measuring Green color*) and the second photosensitive sites (*photosensitive sites measuring Red color*) (*As shown in fig. 7, Denyer et al. discloses that the color signals are read from the array of photosensitive sites 23 by a readout circuit 24 and digitized by an A/D converter (A/D block), the digital signals stored in a 5-line memory 26 and then transmitted to the interpolator (Note that in the processing subsystem, the interpolation is performed by a low pass filter 28 and block 30 (which perform interpolation for determining the luminance values) (See page 18, lines 5-30). This teaches that*

the interpolator receives digital representing the spectral component levels measured in the first photosensitive sites as claimed), and to estimate the level of the first spectral component (*Green color*) in the light received by at least one of the second photosensitive sites (*Photosensitive sites measuring a color other than Green (i.e. Red)*) based on at least one digitized measurement of the first spectral component obtained respectively by at least one of the first photosensitive sites (*Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one digitized measurement of the first spectral component (Green color) to estimate the level of the first spectral component (Green color) in the light received by at least one of the second photosensitive sites since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Green color) is obtained (See page 12, lines 10-19). Denyer et al. also discloses that for luminance determination, the Green color component is calculated by performing interpolation of Green color components surrounding sites that do not receive Green color to obtain the luminance component for said sites (See figs. 3 and 4; page 13, line 8 – page 15, line 20; page 18, lines 5-30)*).

16. **Regarding claim 38**, **Denyer et al.** discloses a plurality of third photosensitive sites (*Fig. 7: 23; see also fig. 1; page 11, lines 29-37; page 12, lines 1-8*), said plurality of third photosensitive sites having a plurality of third color filters (*As shown in fig. 1, Denyer et al. discloses a checkerboard pattern*

filter for Red, Green, and Blue colors. For examination purposes, the Examiner is interpreting the Blue color filters as the plurality of third color filters) arranged above said third photosensitive sites to allow only a third spectral component of light to reach said third photosensitive sites (*Denyer et al. discloses that the pixels are covered with color filters corresponding to desired spectral components. See page 12, lines 1-8. See also fig. 1, which shows the arrangement of Red, Green and Blue colors. This teaches that the third photosensitive sites are covered with a plurality of third color filters (corresponding to Blue color as interpreted by the Examiner) to allow only a third spectral component of light (Blue color) to reach said third photosensitive sites*), wherein each third photosensitive site comprises a configuration enabling each third photosensitive site to measure the level of a third spectral component (*Blue color component*) in light received by the respective third photosensitive site (*Since Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors covering the array of photosensitive sites (See fig. 1). For examination purposes, the Examiner is interpreting the light received by the photosensitive sites with the Blue color filters as the third spectral component in light measured by the respective second photosensitive site*), and

wherein the interpolator further comprises a configuration enabling the interpolator to estimate:

the level of the first spectral component (*Green color*) in the light received by at least one of the third photosensitive sites (*photosensitive sites measuring Blue color*) based on at least one digitized measurement of the first

spectral component (*Green color being digitized by A/D converter as shown in fig. 7. See page 18, lines 5-30*) obtained respectively by at least one of the first photosensitive sites (*photosensitive sites measuring Green color*) (*As discussed in claim 37, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one digitized measurement of the first spectral component (Green color digitized by the A/D converter as shown in fig. 7) to estimate the level of the first spectral component (Green color) in the light received by at least one of the third photosensitive sites (Photosensitive sites measuring Blue color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Green color) is obtained on the photosensitive sites measuring a different color (in this case Blue color) (See page 12, lines 10-19; page 18, lines 5-30)*),

the level of the second spectral component (*Red color*) in the light received by at least one of the third photosensitive sites (*photosensitive sites measuring Blue color*) based on at least one digitized measurement of the second spectral component (*Red color being digitized by A/D converter as shown in fig. 7. See page 18, lines 5-30*) obtained respectively by at least one of the second photosensitive sites (*photosensitive sites measuring Red color*) (*As discussed in claim 37, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one digitized measurement of*

the second spectral component (Red color digitized by the A/D converter as shown in fig. 7) to estimate the level of the second spectral component (Red color) in the light received by at least one of the third photosensitive sites (Photosensitive sites measuring Blue color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Red color) is obtained on the photosensitive sites measuring a different color (in this case Blue color) (See page 12, lines 10-19; page 18, lines 5-30)), and

the level of the third spectral component (*Blue color*) in the light received by at least one of the first photosensitive sites (*photosensitive sites measuring Green color*) and/or at least one of the second photosensitive sites (*photosensitive sites measuring Red color*) based on at least one digitized measurement of the third spectral component (*Blue color being digitized by A/D converter as shown in fig. 7. See page 18, lines 5-30*) obtained respectively by at least one of the third photosensitive sites (*photosensitive sites measuring Blue color*) (*As discussed in claim 37, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one digitized measurement of the third spectral component (Blue color digitized by the A/D converter as shown in fig. 7) to estimate the level of the third spectral component (Blue color) in the light received by at least one of the first photosensitive sites (Photosensitive sites measuring Green color) and/or at least one of the second photosensitive sites (Photosensitive sites measuring Red color) since Denyer et*

al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Green color) is obtained on the photosensitive sites measuring a different color (in this case Green and Red color components) (See page 12, lines 10-19; page 18, lines 5-30)).

17. **Regarding claim 40**, **Denyer et al.** discloses that the first spectral component is a first primary color of light (*As discussed in claims 37 and 38, as interpreted by the Examiner the first spectral component is the Green color which is the first primary color of light*),

the second spectral component is a second primary color of light (*As discussed in claims 37 and 38, as interpreted by the Examiner the second spectral component is the Red color which is the second primary color of light*), and

the third spectral component is a third primary color of light (*As discussed in claims 37 and 38, as interpreted by the Examiner the third spectral component is the Blue color which is the third primary color of light*), Grounds for rejecting claims 37 and 38 apply here.

18. **Regarding claim 42**, **Denyer et al.** discloses that the interpolator includes at least one serial register (*Denyer et al. discloses a plurality of five-pixel registers (Fig. 7: 27)*) for storing digital bit values representing the spectral component measurements from a photosensitive site being interpolated and the

photosensitive sites neighboring the photosensitive site being interpolated (*Denyer et al. discloses that a 5 X 5 block is read out from the memory by 5-pixel registers 27, the block including a photosensitive site being interpolated and the photosensitive sites neighboring the photosensitive site being interpolated. See page 12, lines 10-19; page 18, lines 5-30*).

19. **Regarding claim 58**, **Denyer et al.** discloses that the interpolator further comprises a configuration enabling the interpolator to estimate the level of the first spectral component (*Green color*) in the light received by at least one of the second photosensitive sites (*photosensitive sites measuring Red color*) based on a measurement of the first spectral component (*Green color*) obtained respectively by only a plurality of the first photosensitive sites (*Denyer et al. discloses that the interpolator estimates the level of the first spectral (Green color) component in the light received by at least one of the second photosensitive sites (photosensitive sites measuring Red color) based on a measurement of the first spectral component (Green color) obtained respectively a plurality of the first photosensitive sites by teaching that the missing colors are estimated by applying a lowpass filter to the surrounding photosensitive sites of the color being estimated (See page 12, lines 10-19)*).

20. **Regarding claim 63**, **Denyer et al.** discloses that the interpolator outputs a signal for the at least one of the second photosensitive sites (*i.e. for receiving blue or red color spectral*) that represents light received by the at least one of the

second photosensitive sites associated second color filter (i.e. blue), the signal comprising the estimated level of the first spectral component (green) of light and the measured level of the second spectral component of light (*As discussed in claim 26, Denyer discloses that the green color values (first spectral component) are used to calculate the green spectral component on a second photosite (i.e. for receiving blue or red color spectral). Furthermore, as shown in fig. 7, the tree color values are outputted from the interpolator (see final output after adder 32 wherein the three color values are outputted. This teaches that the interpolator would output both the estimated value as well as the color value detected by the photodiode. See page 12, lines 10-37; page 13, line 8 -page 15, line 20)*).

Claim Rejections - 35 USC § 103

21. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

22. Claims 41, 57 and 64 are rejected under 35 U.S.C. 103(a) as being unpatentable over Denyer et al., WO 97/35438 A1 in view of Acharya, US Patent 6,091,851.

23. **Regarding claim 41**, Denyer et al. does not explicitly disclose that the interpolator output twenty four bits of color data for each photosensitive site, with each color value being represented by eight bits.

However, **Acharya** teaches the concept of performing color recovery of imager captured by a camera (*Fig. 3: 330*) using a single sensor having a Bayer pattern color filter array in order to obtain a full resolution image from an object (*Fig. 3: 340*) being photographed, wherein the individual color components of each pixel area represented by eight bits (*in order to represent a color intensity range from 0-255*) and the pixels of the image after interpolation is performed would have a total resolution of twenty four bits (*Col. 1, lines 4-48; col. 2, lines 40-52; col. 3, lines 16-41; col. 5, line 26 – col. 6, line 26; col. 9, lines 1-8*). Acharya also discloses that the interpolation method can be performed by hardware and firmware and that the interpolation method can be performed by the camera processor (*Fig. 3: 32*) (*Col. 10, lines 7-17*).

Therefore, taking the combined teaching of Denyer et al. in view of Acharya as a whole, one of an ordinary skill in the art, after appreciating the advantages of the interpolation method of Acharya, would find obvious at the time the invention was made to modify the imager of Denyer et al. by having the interpolator output twenty four bits of color data for each photosensitive site, with each color value being represented by eight bits. The motivation to do so would have been to have a desirable amount of color intensity values (256 color intensity values) for each color of each pixel in the image and to better represent luminance in recovering missing color components to have the output image to better resemble the original color of the object prior to its image capture.

24. **Regarding claim 57**, Although Denyer et al. discloses that the interpolator estimates the level of the first spectral (*Green color*) component in the light received by at least one of the second photosensitive sites (*photosensitive sites measuring Red color*) based on a measurement of the first spectral component (*Green color*) obtained respectively a plurality of the first photosensitive sites by teaching that the missing colors are estimated by applying a lowpass filter to the surrounding photosensitive sites of the color being estimated (*See page 12, lines 10-19*), Denyer et al. does not explicitly disclose that the estimation is based on only two of the first photosensitive sites.

However, **Acharya** teaches the concept of performing color interpolation to obtain missing color components on a captured image and discuses the use of only two pixels for estimating color components as a simple approach (*Acharya teaches that for a missing Red color component, the two nearest Red color pixel value would be averaged to estimate said missing Red color component, and the same would be performed for Blue and Green color components to obtain an approximation of the original object's true color. See col. 1, line 49 – col. 2, line 7*).

Therefore, taking the combined teaching of Denyer et al. in view of Acharya as a whole, it would have been obvious to one of an ordinary skill in the art at the time the invention was made to apply the concept of using only two color components to approximate an object's true color component missing at a particular pixel location as taught by Acharya to modify the interpolator of Denyer to estimate the level of the first spectral component (*Green color*) in the light

received by at least one of the second photosensitive sites (*photosensitive sites measuring Red color*) based on a measurement of the first spectral component (*Green color*) obtained respectively by only two of the first photosensitive sites. The motivation to do so would have been to calculate the missing color components using a simple interpolation method that would reduce the time for estimating the missing color components as an alternative to using a 5 x 5 pixel kernel, thus allowing increasing the speed of the interpolation process.

Regarding claim 64, **Denyer et al.** does not explicitly disclose that the interpolator estimates the level of the first spectral component in the light received by the at least one of the second photosensitive sites based on measurements of the first spectral component obtained respectively by at least two of the first photosensitive sites located in a same row as the at least one of the second photosensitive sites. However, Acharya teaches the concept of performing color recovery of imager captured by a camera (*Fig. 3: 330*) using a single sensor having a Bayer pattern color filter array in order to obtain a full resolution image from an object (*Fig. 3: 340*) being photographed, wherein the color components of a particular pixel (i.e. blue pixel in position (6, 3) as shown in fig. 2) the values of two adjacent green pixels in the row and the values of two adjacent pixels in a column are used to calculate the green color on said blue pixel (*Col. 1, lines 4-48; col. 2, lines 40-52; col. 3, lines 16-41; col. 5, line 26 – col. 6, line 26; col. 9, lines 1-8*). Acharya also discloses that the interpolation method can be performed by hardware and firmware and that the interpolation

method can be performed by the camera processor (*Fig. 3: 32*) (*Col. 10, lines 7-17*).

Therefore, taking the combined teaching of Denyer et al. in view of Acharya as a whole, one of an ordinary skill in the art, after appreciating the advantages of the interpolation method of Acharya, would find obvious at the time the invention was made to modify the imager of Denyer et al. by having the interpolator using measurements of the first spectral component obtained respectively by at least two of the first photosensitive sites located in a same row as the at least one of the second photosensitive sites as an alternative to the method in Denyer. The motivation to do so would have been to use an alternative method to calculate the colors not present in a particular photosite using the color values that would contribute the most into approximating the real color for a predetermined target pixel.

25. Claims 43 and 59-62 are rejected under 35 U.S.C. 103(a) as being unpatentable over Denyer et al., WO 97/35438 A1 in view of Sakurai et al., US Patent 5,990,946.

26. **Regarding claim 43**, Denyer et al. does not explicitly disclose that for estimating a spectral component level for a photosensitive site, the interpolator digitally weights the values of the spectral component being estimated, as measured by the photosensitive sites providing the measurements and which are currently stored in the at least one serial register, based on the distances of the

photosensitive sites providing the measurements from the photosensitive site for which the spectral component is being estimated.

However, **Sakurai et al.** teaches a digital camera (*See figs. 12 and 14*), comprising an imager (*See fig. 12: 104 and fig. 14: 90*) for capturing an image; an A/D converter (*Fig. 12: 107*) for digitizing the color signals received from the imager (*Col. 7, lines 21-60*) to be memorized in a memory (*254 as shown in fig. 12; see also memory 91 as shown in fig.14*) and a color interpolation circuit (*Color interpolation circuit 3 as shown in figs. 14 and 15*) for estimating the color components missing on each photosensitive site (*Col. 8, line 17 – col. 9, line 26*). Sakurai et al. further teaches that the color interpolation circuit comprises five multipliers (*See fig. 17: 12-16*) for weighting the values of the spectral component being estimated, as measured by the photosensitive sites providing the measurements and which are currently stored in at least one serial register *(Sakurai et al. discloses using a plurality of delay units (Fig. 17: 8-11) for storing the spectral components being estimated (See col. 10, lines 9-27). Since the delay units are used to hold the spectral components being estimated for further performing interpolation to said spectral components, the Examiner is reading the delay units 8-11 as a serial register since the spectral components measured, which are received from the memory, are shifted from each of the delay units to be output to the multipliers 8-11 for weighting the spectral components. See col. 10, lines 9-27*), based on the distances of the photosensitive sites providing the measurements from the photosensitive site for which the spectral component is being estimated (*In col. 9, line 48 – col. 10, line 6, Sakurai et al. teaches a*

plurality of equations that are applied to the spectral components by the interpolation circuit. It is noted that a lower weighting coefficient is applied to spectral components far from the target pixel to be estimated. For example the estimation for an n2 line (See lines in the portion of fig. 16 below), would be defined as:

$$Mg=1/2(1/2Mg12+1/2Mg14)+1/2(1/4Mg31+1/2Mg33+1/4Mg35)$$

$$G=1/2(1/4G11+1/2G13+1/4G15)+1/2(1/2G32+1/2G34)$$

$$Ye=1/2(1/2Ye22+Ye24)$$

$$Cy=1/2(1/2Cy21+Cy23+1/2Cy25),$$

It is noted that Mg31 and Mg35 are receiving a lower weighting coefficient (1/4), which is assigned based on the distance from the target pixel since said pixels are far from the target pixel and pixels that are closer to the target pixel are receiving a larger weighting coefficient (1/2). The same occurs for other estimations in the same line as well as other lines.).

FIG.16

G11	Mg12	G13	Mg14	G15	Mg16	n1
Cy21	Ye22	Cy23	Ye24	Cy25	Ye26	n2
Mg31	G32	Mg33	G34	Mg35	G36	n3
Cy41	Ye42	Cy43	Ye44	Cy45	Ye46	n4
G51	Mg52	G53	Mg54	G55	Mg56	n5
Cy61	Ye62	Cy63	Ye64	Cy65	Ye66	n6

Applying a weighting coefficient that is associated to the distance from the target pixel is advantageous because it would provide a smooth (natural) continuity for the image formed of the filtered spectral components.

Therefore, taking the combined teaching of Denyer et al. in view of Sakurai et al. as a whole, it would have been obvious to one of an ordinary skill in the art at the time the invention was made to apply the concept of weighting the values of the spectral component being estimated, which are currently stored in a serial register, based on the distances of the photosensitive sites providing the measurements from the photosensitive site for which the spectral component is being estimated as taught by Sakurai et al. to modify the teaching of Denyer et al. to have the interpolator digitally weighting the values of the spectral component being estimated, as measured by the photosensitive sites providing the measurements and which are currently stored in the at least one serial register, based on the distances of the photosensitive sites providing the measurements from the photosensitive site for which the spectral component is being estimated. The motivation to do so would have been to provide a smooth (natural) continuity for the image formed of the filtered spectral components.

Regarding claims 59-62, Denyer et al. discloses the interpolator comprises at least one serial register (*Denyer et al. discloses a plurality of five-pixel registers (Fig. 7: 27)*) for storing digital bit values representing the spectral component measurements from a photosensitive site being interpolated and a plurality photosensitive sites neighboring the photosensitive site (*24 photosensitive sites neighboring the photosensitive site being interpolated in the 5 x 5 block*) being interpolated (*Denyer et al. discloses that the color signals are read from the array of photosensitive sites 23 by a readout circuit 24 and*

digitized by an A/D converter (A/D block), the digital signals stored in a 5-line memory 26 and then transmitted to the interpolator (Note that in the processing subsystem, the interpolation is performed by a low pass filter 28 and block 30 (which perform interpolation for determining the luminance values) (See page 18, lines 5-30). This teaches that the register stores digital bit values representing the spectral component measurements from a photosensitive site being interpolated and the photosensitive sites neighboring the photosensitive site being interpolated). Denyer et al. does not explicitly disclose the plurality of photosensitive sites stored in the at least one serial register are four photosensitive sites;

that the interpolator further comprises five scalar multipliers for multiplying the digital bit values of the spectral component measurements from the photosensitive site being interpolated and the four photosensitive sites neighboring the photosensitive site being interpolated;

a first adder for adding the digital bit value of a first of the four photosensitive sites neighboring the photosensitive site being interpolated to a second of the four photosensitive sites neighboring the photosensitive site and a second adder for adding the digital bit value of a third of the four photosensitive sites neighboring the photosensitive site being interpolated to a fourth of the four photosensitive sites neighboring the photosensitive site; and

a first dividing circuit for dividing in half a summation of the first and second of the four photosensitive sites neighboring the photosensitive site being interpolated and a second dividing circuit for dividing in half a summation of the

third and fourth of the four photosensitive sites neighboring the photosensitive site being interpolated.

However, **Sakurai et al.** teaches a digital camera (*See figs. 12 and 14*), comprising an imager (*See fig. 12: 104 and fig. 14: 90*) for capturing an image; an A/D converter (*Fig. 12: 107*) for digitizing the color signals received from the imager (*Col. 7, lines 21-60*) to be memorized in a memory (*254 as shown in fig. 12; see also memory 91 as shown in fig.14*) and a color interpolation circuit (*Color interpolation circuit 3 as shown in figs. 14 and 15*) for estimating the color components missing on each photosensitive site (*Col. 8, line 17 – col. 9, line 26*). Sakurai et al. further teaches using a plurality of delay units (*Fig. 17: 8-11*) for shifting five spectral components, a color component being interpolated and four color components neighboring the color component being estimated (*See col. 10, lines 9-27*; *Since the delay units are used to hold the spectral component being estimated and the four spectral components neighboring the spectral component being estimated for further performing interpolation to said spectral components, the Examiner is reading the delay units 8-11 as a serial register since the spectral components measured, which are received from the memory, are shifted from each of the delay units to be output to a plurality of multipliers 8-11 for weighting the spectral components. See col. 10, lines 9-41*). Sakurai et al. further teaches that the color interpolation circuit further comprises a plurality of interpolation filters (*5-7 as shown in fig. 17*) each five scalar multipliers (*Coefficient setting units 12-16 as shown in fig. 17*) for multiplying the digital bit values of the spectral component measurements from the photosensitive site

being interpolated (*it is noted that the interpolation color filters 5-7 contain the same structure for interpolating missing components (See col. 10, lines 9-41) and that the color component that is being interpolated would receive a weight value when used for estimating the same spectral component missing at a different location since the output of said interpolation color filters 5-7 are further used to obtain the values of the spectral components missing in the obtained image data to satisfy the equations shown in col. 9, line 47 - col. 10, line 6 (See also col. 10, lines 9-41). Therefore, Sakurai et al. teaches that a scalar multiplier multiplies the digital bit values of the spectral component measurements from the photosensitive site being interpolated*) and the four photosensitive sites neighboring the photosensitive site being interpolated (*Sakurai et al. teaches that the coefficient setting units 12-16 are used to apply a weighting value to the spectral components being interpolated. Coefficient setting units 12 and 16 apply a 1/4 weighting value and coefficient setting units 13-15 apply a 1/2 weighting value to the spectral components being interpolated. See fig. 17; see also col. 9, line 27 – col. 10, line 36. As discussed above, it is noted that Sakurai et al. teaches combining the outputs of the interpolation filters to yield a particular color component. As shown in fig. 7, the color components can be obtained from four values of the spectral components. For example, to satisfy the equation for estimating a Ye color component,*

Ye = ½ (½Ye42 + ½Ye44) + ½ (½Ye62 + ½Ye64), it is noted that four values of the Ye spectral components have been assigned a particular weight value (½) and have been interpolated to estimated the Ye component missing at position

G53 (line n5 as shown in fig. 16). This also teaches that the estimation for the different color components may be performed by the use of different amount of spectral components measured by the photosensitive sites and furthermore, Sakurai et al. further teaches that the estimation bay be performed by using either one-dimensional filter, two-dimensional filters and while the block as taught corresponds to lines of 5 pixels, the lines may be of 3 or 7 pixels (See col. 10, lines 33-41). This suggests the use of any desired amount of photosensitive site values for estimating the missing color components in the image));

a first adder (*See fig. 17: 17*) for adding the digital bit value of a first of the four photosensitive sites (*corresponding to spectral component being weighted by coefficient setting unit 12 as shown in fig. 17*) neighboring the photosensitive site being interpolated to a second of the four photosensitive sites (*corresponding to spectral component being weighted by coefficient setting unit 16 as shown in fig. 17*) neighboring the photosensitive site and a second adder (*See fig. 17: 18*) for adding the digital bit value of a third of the four photosensitive sites (*corresponding to spectral component being weighted by coefficient setting unit 13 as shown in fig. 17*) neighboring the photosensitive site being interpolated to a fourth of the four photosensitive sites (*corresponding to spectral component being weighted by coefficient setting unit 15 as shown in fig. 17*) neighboring the photosensitive site (*See fig. 17; see also col. 9, line 27 – col. 10, line 3*); and

a first dividing circuit (*Coefficient setting unit 19 as shown in fig. 17*) for dividing in half a summation of the first and second of the four photosensitive

sites (*corresponding to spectral components being weighted by coefficient setting units 12 and 16 as shown in fig. 17*) neighboring the photosensitive site being interpolated and a second dividing circuit (*Coefficient setting unit 20 as shown in fig. 17*) for dividing in half a summation of the third and fourth of the four photosensitive sites (*corresponding to spectral components being weighted by coefficient setting units 13 and 15 as shown in fig. 17*) neighboring the photosensitive site being interpolated.

Therefore, taking the combined teaching of Denyer et al. in view of Sakurai et al., after acknowledging the teaching of estimating the missing color components in an image by using the values a plurality spectral components being weighted by a plurality of multipliers, added and divided by half and that the estimation may be perform by different amounts of values of a spectral component, including four values to obtain the missing color component at a particular location as taught by Sakurai et al., it would have been obvious to one of an ordinary skill in the art at the time the invention was made to modify the interpolator of Denyer et al. to have the plurality of photosensitive sites stored in the at least one serial register are four photosensitive sites; to have the interpolator with a structure comprising five scalar multipliers for multiplying the digital bit values of the spectral component measurements from the photosensitive site being interpolated and the four photosensitive sites neighboring the photosensitive site being interpolated; a first adder for adding the digital bit value of a first of the four photosensitive sites neighboring the photosensitive site being interpolated to a second of the four photosensitive sites

neighboring the photosensitive site and a second adder for adding the digital bit value of a third of the four photosensitive sites neighboring the photosensitive site being interpolated to a fourth of the four photosensitive sites neighboring the photosensitive site; and a first dividing circuit for dividing in half a summation of the first and second of the four photosensitive sites neighboring the photosensitive site being interpolated and a second dividing circuit for dividing in half a summation of the third and fourth of the four photosensitive sites neighboring the photosensitive site being interpolated. The motivation to do so would have been to provide an alternative structure to the interpolator in Denyer et al. to perform the estimation of the missing color components with the purpose of producing a smooth (natural) continuity for the image formed of the filtered spectral components.

27. Claims 44-48 are rejected under 35 U.S.C. 103(a) as being unpatentable over Denyer et al., WO 97/35438 A1 in view of Denyer et al., WO 97/20434 A1 (thereinafter referred as Denyer et al. '434).

28. **Regarding claim 44**, **Denyer et al.** discloses an imaging device (*See figs. 1 and 7*), comprising:

an imager (*See fig. 7: 23*) which comprises

a substrate (*Denyer et al. discloses a semiconductor substrate by disclosing that the imager is part of a single chip camera and that the production process of the image sensor is well disposed to deposition of the color filters when the products are in silicon-wafer form. See fig. 7, page 16, lines 13-21*);

an M x N array of photosensitive sites (*See fig. 1; see also fig. 7: 23*) located on the substrate (*Note that the sensor array 23 is located on the single camera chip 20 as shown in fig. 7 (See page 18, lines 5-30; also page 12, lines 1-8*), the array including

a plurality of first photosensitive sites (*Fig. 7: 23; see also fig. 1; page 11, lines 29-37; page 12, lines 1-8*) located on the substrate (*Note that the sensor array 23 is located on the single camera chip 20 as shown in fig. 7 (See page 18, lines 5-30; also page 12, lines 1-8). This teaches that the plurality of first photosensitive sites is located on the substrate*), said plurality of first photosensitive sites (*See fig. 1*) having a plurality of first color filters (*As shown in fig. 1, Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors. For examination purposes, the Examiner is interpreting the Green color filters as the plurality of first color filters*) arranged above said first photosensitive sites to allow only a first spectral component of light to reach said first photosensitive sites (*Denyer et al. discloses that the pixels are covered with color filters corresponding to desired spectral components. See page 12, lines 1-8. See also fig. 1, which shows the arrangement of Red, Green and Blue colors. This teaches that the first sensitive sites are covered with a plurality of first color filters (corresponding to green color as interpreted by the Examiner) to allow only a first spectral component (Green) of light to reach said first photosensitive sites*), wherein each first photosensitive site comprises a configuration enabling each first photosensitive site to measure the level of a first spectral component (Green

color components) in light received by the respective first photosensitive site (*See page 12, lines 1-19*);

a plurality of second photosensitive sites (*Fig. 7: 23; see also fig. 1; page 11, lines 29-37; page 12, lines 1-8*) located on the substrate (*Note that the sensor array 23 is located on the single camera chip 20 as shown in fig. 7 (See page 18, lines 5-30; also page 12, lines 1-8). This teaches that the plurality of second photosensitive sites is located on the substrate*), said plurality of second photosensitive sites having a plurality of second color filters (*As shown in fig. 1, Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors. For examination purposes, the Examiner is interpreting the Blue color filters as the plurality of second color filters*) arranged above said second photosensitive sites to allow only a second spectral component of light to reach said second photosensitive sites (as discussed above, *Denyer et al. discloses that the pixels are covered with color filters corresponding to desired spectral components. See page 12, lines 1-8. See also fig. 1, which shows the arrangement of Red, Green and Blue colors. This teaches that the second sensitive sites are covered with a plurality of second color filters (corresponding to Red color as interpreted by the Examiner) to allow only a first spectral component (Green) of light to reach said first photosensitive sites*), wherein each second photosensitive site comprises a configuration enabling each second photosensitive site to measure the level of a second spectral component (*Red color component*) in light received by the respective second photosensitive site, said second spectral component being different from said first spectral

component (*Note that the Examiner is interpreting the first color component as Green and the second color component as Red, which are different from each other*); and

an interpolator (*See processor subsystem 25 as shown in fig. 7. Denyer et al. discloses performing interpolation on the color components using low-pass filter 28 and also teaches performing interpolation for obtaining the luminance components of the captured image data. See page 18, lines 5-30; see also page 12, lines 10-37; page 13, line 8 – page 14, line 10; page 15, lines 1-20*) located on the substrate (*Denyer et al. discloses that the processor subsystem is located on the same chip as the array of photosensitive sites. See page 18, lines 5-30; also page 16, lines 13-21*) and comprising a configuration to receive digitized color component values (*digitized by A/D converter (A/D block as shown in fig. 7)*) corresponding to the measurements obtained in the first photosensitive sites (*photosensitive sites measuring Green color*) and the second photosensitive sites (*photosensitive sites measuring Red color*) (*As shown in fig. 7, Denyer et al. discloses that the color signals are read from the array of photosensitive sites 23 by a readout circuit 24 and digitized by an A/D converter (A/D block), the digital signals stored in a 5-line memory 26 and then transmitted to the interpolator (Note that in the processing subsystem, the interpolation is performed by a low pass filter 28 and block 30 (which perform interpolation for determining the luminance values) (See page 18, lines 5-30). This teaches that the interpolator receives digital representing the spectral component levels measured in the first photosensitive sites as claimed*), to estimate the level of the

first color component (*Green color*) in the light received by at least one of the second photosensitive sites (*Photosensitive sites measuring a color other than Green (i.e. Red)*) based on at least one digitized color component obtained respectively by at least one of the first photosensitive sites (*Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one digitized measurement of the first spectral component (Green color) to estimate the level of the first spectral component (Green color) in the light received by at least one of the second photosensitive sites since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Green color) is obtained (See page 12, lines 10-19). Denyer et al. also discloses that for luminance determination, the Green color component is calculated by performing interpolation of Green color components surrounding sites that do not receive Green color to obtain the luminance component for said sites (See figs. 3 and 4; page 13, line 8 – page 15, line 20; page 18, lines 5-30)*) and to estimate the level of the second color component (*Red color*) in the light received by at least one of the first photosensitive sites (*Photosensitive sites measuring Green color*) based on at least one digitized color component obtained respectively from at least one of the second photosensitive sites (*Photosensitive sites measuring Red color*) (*As discussed above, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one digitized second color*

component (Red color digitized by A/D converter as shown in fig. 7) to estimate the level of the second color component (Red color) in the light received by at least one of the first photosensitive sites (Photosensitive sites measuring Green color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Red color) is obtained (See page 12, lines 10-19)).

Denyer et al. does not explicitly disclose a display for displaying an image on an array of M x N pixels.

However, **Denyer et al. '434** discloses an imaging device (*See figs. 3 and 4*), comprising:

a display (*Fig. 4: 30*) for displaying an image on an array of M x N pixels (*page 11, line 33 – page 12, line 25*); and

an imager (*Fig. 3: 1 and 4: 1*) which comprises

a substrate (*by teaching that the imaging array is located in a chip, Denyer et al. discloses a semiconductor substrate; see page 13, lines 1-22*),

an M x N array of photosensitive sites located on the substrate (*fig. 3 shows an M x N array of pixels 2*), the array including

a plurality of first photosensitive sites located in the substrate (*the array in Denyer et al. is divided into three kind of photosensitive sites (red, green and blue); see fig. 2; page 10, line 23 – page 12, line 32*), wherein each first photosensitive site is configured to measure the level of a first color (*i.e. green*) component in light received by the respective first photosensitive site, and

a plurality of second photosensitive sites (*the array in Denyer et al. is divided into three kind of photosensitive sites (red, green and blue); see fig. 2; page 10, line 23 – page 12, line 32) located in the substrate, wherein each second photosensitive site is configured to measure the level of a second color component (i.e. red color) in light received by the respective second photosensitive site (taking in consideration green, red and blue as a first, second and third spectral components for examining purposes, the second spectral components can be read as red. Denyer et al. discloses measuring red, green and blue colors as discussed in claim 26 above*), said second spectral component being different from said first spectral component (*the array in Denyer et al. is divided into three kind of photosensitive sites (red, green and blue); see fig. 2; page 10, line 23 – page 12, line 32. This teaches that the second spectral component being different from said first spectral component as claimed since each photosensitive site is receiving a single color spectral of the three colors that the full array receives*); and

an interpolator (*Denyer et al. discloses a processing unit (Fig. 4: 28) to perform color interpolation to the red, green and blue signals to form synchronous, parallel color channel signals for the video signal before being output to a display unit (Fig. 4: 30); page 11, line 33 – page 12, line 25*) located on the substrate (*Denyer et al. discloses that the processing unit can be incorporated in the same chip, where the imaging array is located; page 13, lines 1-22*) and configured to receive digitized color component values (*output from an A/D converter 26 as shown in fig. 4; page 11, line 33 – page 13, line 23*)

corresponding to the measurements obtained in the first and second photosensitive sites, to estimate the level of the color component in the light received by at least one of the second photosensitive sites based on at least one digitized color component value obtained respectively from at least one of the other photosensitive sites, and to estimate the level of the second color component in the light received by at least one of the other photosensitive sites based on at least one digitized color component value obtained respectively from at least one of other photosensitive sites (*Denyer et al. discloses reconstructing the image colors of each pixels by performing interpolation to obtain an RGB value for each pixel location) (Page 10, line 23 – page 13, line 22*).

Having an imaging device including a display for displaying an image on an array of M x N pixels is advantageous because it improve the portability of the imaging device by allowing the user to review the captured image data on the same device.

Therefore, taking the combined teaching of Denyer et al. in view of Denyer et al. '434 as a whole, it would have been obvious to one of an ordinary skill in the art at the time the invention was made to apply the concept of having an imaging device with a display for displaying the images captured by said imaging device as taught in Denyer et al. '434 to modify the imaging device of Denyer et al. to include a display for displaying an image on an array of M x N pixels. The motivation to do so would have been to improve the portability of the imaging device by allowing the user to review the captured image data on the same device.

29. **Regarding claim 45**, the combined teaching of Denyer et al. in view of Denyer et al. '434 further teaches that the interpolator estimates the color component level not measured in each respective photosensitive site in at least one line of photosensitive sites in the array during a readout operation (*Denyer et al. discloses that five lines of five pixels forming a block are read out from the array of photosensitive sites 23 and output to an A/D converter (A/D block as shown in fig. 7), that would further output the digitized signals to a five-line memory (Fig. 7: 26) and the subjected to color interpolation (using lowpass filter 28 and block 30 (which perform interpolation for determining the luminance values) to obtain the missing colors in a respective site) (See page 18, lines 5-30). Therefore, Denyer et al. discloses that the interpolator estimates the color component level not measured in each respective photosensitive site in at least one line of photosensitive sites in the array during a readout operation since the block in Denyer et al is formed by a plurality of lines*).

30. **Regarding claim 46**, the combined teaching of Denyer et al. in view of Denyer et al. '434 further teaches that the interpolator estimates the color component level not measured in each respective photosensitive site in several sequential lines of photosensitive sites in the array during a readout operation (*Denyer et al. discloses that five lines of five pixels forming a block are read out from the array of photosensitive sites 23 and output to an A/D converter (A/D block as shown in fig. 7), that would further output the digitized signals to a five-line memory (Fig. 7: 26) and the subjected to color interpolation (using lowpass*

filter 28 and block 30 (which perform interpolation for determining the luminance values) to obtain the missing colors in a respective site) (See page 18, lines 5-30). Therefore, Denyer et al. discloses that the interpolator estimates the color component level not measured in each respective photosensitive site in several sequential lines of photosensitive sites in the array during a readout operation since the block in Denyer et al is formed by a plurality of sequential lines).

31. **Regarding claim 47**, the combined teaching of Denyer et al. in view of Denyer et al. '434 further teaches that the interpolator estimates the color component level not measured in each respective photosensitive site in a block of photosensitive sites in the array during a readout operation (*Denyer et al. discloses that five lines of five pixels forming a block are read out from the array of photosensitive sites 23 and output to an A/D converter (A/D block as shown in fig. 7), that would further output the digitized signals to a five-line memory (Fig. 7: 26) and the subjected to color interpolation (using lowpass filter 28 and block 30 (which perform interpolation for determining the luminance values) to obtain the missing colors in a respective site) (See page 18, lines 5-30). Therefore, Denyer et al. discloses that the interpolator estimates the color component level not measured in each respective photosensitive site in a block of photosensitive sites in the array during a readout operation*).

32. **Regarding claim 48**, the combined teaching of Denyer et al. in view of Denyer et al. '434 further teaches a plurality of third photosensitive sites (*Fig. 7: 23; see also fig. 1; page 11, lines 29-37; page 12, lines 1-8*), said plurality of third

photosensitive sites having a plurality of third color filters (*As shown in fig. 1, Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors. For examination purposes, the Examiner is interpreting the Blue color filters as the plurality of third color filters*) arranged above said third photosensitive sites to allow only a third spectral component of light to reach said third photosensitive sites (*Denyer et al. discloses that the pixels are covered with color filters corresponding to desired spectral components. See page 12, lines 1-8. See also fig. 1, which shows the arrangement of Red, Green and Blue colors. This teaches that the third photosensitive sites are covered with a plurality of third color filters (corresponding to Blue color as interpreted by the Examiner) to allow only a third spectral component of light (Blue color) to reach said third photosensitive sites*), wherein each third photosensitive site comprises a configuration enabling each third photosensitive site to measure the level of a third spectral component (*Blue color component*) in light received by the respective third photosensitive site (*Since Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors covering the array of photosensitive sites (See fig. 1). For examination purposes, the Examiner is interpreting the light received by the photosensitive sites with the Blue color filters as the third spectral component in light measured by the respective second photosensitive site*), and

wherein the interpolator further comprises a configuration enabling the interpolator to estimate:

the level of the first color component (*Green color*) in the light received by at least one of the third photosensitive sites (*photosensitive sites measuring Blue color*) based on at least one digitized measurement of the first color component (*Green color being digitized by A/D converter as shown in fig. 7. See page 18, lines 5-30*) obtained respectively by at least one of the first photosensitive sites (*photosensitive sites measuring Green color*) (*As discussed in claim 37, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one digitized measurement of the first color component (Green color digitized by the A/D converter as shown in fig. 7) to estimate the level of the first color component (Green color) in the light received by at least one of the third photosensitive sites (Photosensitive sites measuring Blue color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Green color) is obtained on the photosensitive sites measuring a different color (in this case Blue color) (See page 12, lines 10-19; page 18, lines 5-30)*),

the level of the second color component (*Red color*) in the light received by at least one of the third photosensitive sites (*photosensitive sites measuring Blue color*) based on at least one digitized measurement of the second color component (*Red color being digitized by A/D converter as shown in fig. 7. See page 18, lines 5-30*) obtained respectively by at least one of the second photosensitive sites (*photosensitive sites measuring Red color*) (*As*

discussed in claim 37, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one digitized measurement of the second color component (Red color digitized by the A/D converter as shown in fig. 7) to estimate the level of the second color component (Red color) in the light received by at least one of the third photosensitive sites (Photosensitive sites measuring Blue color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Red color) is obtained on the photosensitive sites measuring a different color (in this case Blue color) (See page 12, lines 10-19; page 18, lines 5-30)), and

the level of the third color component (*Blue color*) in the light received by at least one of the first photosensitive sites (*photosensitive sites measuring Green color*) and/or at least one of the second photosensitive sites (*photosensitive sites measuring Red color*) based on at least one digitized measurement of the third color component (*Blue color being digitized by A/D converter as shown in fig. 7. See page 18, lines 5-30*) obtained respectively by at least one of the third photosensitive sites (*photosensitive sites measuring Blue color*) (*As discussed in claim 37, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one digitized measurement of the third color component (Blue color digitized by the A/D converter as shown in fig. 7) to estimate the level of the third color component*

(Blue color) in the light received by at least one of the first photosensitive sites (Photosensitive sites measuring Green color) and/or at least one of the second photosensitive sites (Photosensitive sites measuring Red color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Green color) is obtained on the photosensitive sites measuring a different color (in this case Green and Red color components) (See page 12, lines 10-19; page 18, lines 5-30)).

Conclusion

33. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Contact

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Nelson D. Hernández Hernández whose telephone number is (571)272-7311. The examiner can normally be reached on 9:00 A.M. to 5:30 P.M.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Lin Ye can be reached on (571) 272-7372. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Lin Ye/
Supervisory Patent Examiner, Art Unit 2622

NDHH
January 5, 2010